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TITLE: Methods and apparatus for simulating competitive bidding yield

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ABSTRACT: A method of valuation of groups of assets by partial full underwriting, partial sample underwriting and inferred values of the remainder using an iterative and adaptive statistical evaluation of all assets. Statistical inferences drawn from the evaluation are applied to generate the inferred values. The assets are collected into a database, catagorized, subdivided by ratings as to those variables and then rated individually. The assets are then regrouped according to a bidding grouping and a collective valuation is established. Simulated bid scenarios are examined for combinations of bid prices and a best bid price according to risk and return is determined.

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Abstract Paragraph - ABTX (1): A method of valuation of groups of assets by partial full underwriting, partial sample underwriting and inferred values of the remainder using an iterative and adaptive statistical evaluation of all assets. Statistical inferences drawn from the evaluation are applied to generate the inferred values. The assets are collected into a database, catagorized, subdivided by ratings as to those variables and then rated individually. The assets are then regrouped according to a bidding grouping and a collective valuation is established. Simulated bid scenarios are examined for combinations of bid prices and a best bid price according to risk and return is determined.

Summary of Invention Paragraph - BSTX (4): [0004] Bidders may submit bids on all tranches, or on only some tranches. In order to win a tranche, a bidder typically must submit the highest bid for that tranche. In connection with determining a bid amount to submit on a particular tranche, a bidder often will engage underwriters to evaluate as many loans as possible within a tranche and within the available limited time. When the time for submitting a bid is about to expire, the bidder will evaluate the loans underwritten at that time, and then attempt to extrapolate a value to the loans that have not then been analyzed by the underwriters.

Summary of Invention Paragraph - BSTX (5): [0005] Traditionally, bids and offers are established based upon an asset's inherent worth and a knowledge of the competitive context. Investment and/or divestiture committees of entities making bids come to consensus on minimum and

maximum prices they will unilaterally make. As a result of this process, a bidder may significantly undervalue a tranche and submit a bid that is not competitive or bid higher than the underwritten value and assume unquantified risk. Of course, since the objective is to win each tranche at a price that enables a bidder to earn a return, losing a tranche due to significant undervaluation of the tranche represents a lost opportunity. It would be desirable to provide a system that facilitates accurate valuation of a large number of financial instruments in a short period of time and understand the associated probabilities of return for a given bid. It would be further desirable to determine a bid price for each tranche of a portfolio of financial instruments in a sealed bid auction.

Summary of Invention Paragraph - BSTX (8): [0007] As the process proceeds and more assets are underwritten, the number of assets in the first and second portions increase and the number of assets in the third portion decreases and the variance of the valuation of the assets in the third portion becomes more and more defined. More specifically, the assets in the third portion are evaluated by grouping the assets into clusters based on similarity to valuations of assets in the first and second portions. Hypothetical bids are generated using the valuations to determine an optimum bid within parameters determined by the bidder. The optimum bid is identified through an iterative bid generation process. A bid price for each tranche of a portfolio of financial instruments in a sealed bid auction is determined by simulating a bid opening process and determining an optimal bid that returns the highest probability of a successful bid.

Detail Description Paragraph - DETX (7): [0027] "Underwriting" as used herein means a process in which a person ("underwriter") reviews an asset in accordance with established principles and determines a current purchase price for buying the asset. During underwriting, the underwriter uses pre-existing or established criteria 80 for the valuations. "Criteria" means rules relevant to asset value and a rating based on such categories. For example, as a criteria, an underwriter might determine three years of cash flow history of the borrower to be a category of information relevant to asset valuation and might give a certain rating to various levels of cash flow.

Detail Description Paragraph - DETX (11): [0031] Automatic valuation procedure 40 utilizes supervised learning process 206, an unsupervised learning process 208 and an upload from a statistical inferencing algorithm 134 to generate an underwriting clusters table 136 which is stored in a digital storage device. In supervised learning process 206, an experienced underwriter who knows what questions to ask to establish value, assists the computer in determining whether or not an asset is a good investment and how to value the asset. In unsupervised learning process 208, the computer segments and classifies assets and objectively self-evaluates the assets based on feedback from the data. An underwriter periodically reviews the unsupervised learning process 208 to determine whether the computer is making sensible underwriting conclusions. The computer uses statistical algorithms 134 to make its inferences. For example, but not by way of limitation, one embodiment uses the Design For Six Sigma ("DFSS") quality paradigm developed and used by General Electric Company and applied in a Due Diligence ("DD") asset valuation process using a multi-generational product development ("MGPD") mode to value the asset data with increasing accuracy. Learning processes 206 and 208 incorporate the accumulated knowledge as the valuation progresses into cash flow recovery and probability of recovery calculations on an

ongoing, real time basis. Supervised learning process 206 uses business rules to identify clusters of assets having common aspects for valuation purposes. Unsupervised learning process 208 uses feedback from prior data valuations performed by procedure 40 to determine if progress is being made with respect to increasing valuation confidence. Identification of all available raw data and discovery of interrelationships of clusters of these available raw data is possible due to the use of high-speed computers, as is described below.

Detail Description Paragraph - DETX (14): [0034] Organizing valuation scores is performed by collating, in electronic form, a cluster number, a cluster name, descriptive attributes of the cluster(s), probabilistic recovery values (an illustrative example is a HELTR score) and the underwriter's confidence in each cluster's valuation based upon the strengths of each cluster's descriptive attributes. The cluster number is a unique identifier of a specific set of descriptive attributes that are facts about an asset which a person skilled in evaluations uses to assess value of an asset. Examples of descriptive attributes include, but are not limited to, payment status, asset type, borrower's credit worthiness expressed as a score, location and seniority of a claim. The cluster name is, in one embodiment, an alpha-numeric name that describes the cluster's descriptive attributes or sources. One example of descriptive attributes is found in FIG. 12, described below.

Detail Description Paragraph - DETX (18): [0038] A cluster's valuation and confidence is determined at a point in time and recorded. Sometimes new information becomes available and the analyst would like to alter the value(s). The value is altered manually or automatically with a data field and decision rules, in the automated fashion via computer code. The prior values are manipulated to reflect new information. As an illustrative example, assume the prior cluster confidence was recorded at 0.1 and it is learned that a different asset with exact descriptive attributes as in this cluster just sold for over the predicted "most probable" value. Rules were in effect such that if this event occurred, cluster confidence is multiplied by 10.  $0.1 \times 10 = 1$  which is the revised cluster confidence.

Detail Description Paragraph - DETX (26): [0045] An expected value,  $Y_{sub.expect}$ , of the response variable is calculated according to:

Detail Description Paragraph - DETX (33): [0050] FIG. 4 is a flow diagram of a bid preparation stage 168 performed by system 28 (shown in FIG. 2). The cumulated valuations 98, 104, 118, 132, 142 and 144 are combined in a risk preference loan level valuation step 146. A deterministic cash flow bridge 148 is produced using a cash flow timing table 150 to develop a stochastic cash flow bridge 152. A stochastic or probabilistic cash flow bridge 152 is created and used to determine a proposed tranche bid price 154 to which is applied a tranche model 156 iteratively until a certain threshold 158 is reached. Threshold 158 is, for example, an internal rate of return ("IRR") greater than some value, a certain time to profit ("TTP"), and a positive net present value ("NPV").

Detail Description Paragraph - DETX (38): [0055] If threshold conditions 160 are met, bid 154 is subjected to a simulated bid opening analysis 161 to predict whether the bid can be expected to be a winning bid. An outcome of a sealed bid auction depends on sizes of the bids received from

each bidder. Execution of the auction involves opening all of the bids and selling the items up for auction to the highest bidder. In traditional sealed bid auctions, bidders are not allowed to change their bids once their bid is submitted and bidders do not know the bids placed by other bidders until the bids are opened, making the outcome of the auction uncertain. By placing higher bids, a probability that the auction will be won is higher, but value gain is lower if it was possible to have won the auction at a lower price.

Detail Description Paragraph - DETX (39): [0056] Simulating competitive bidding increases the probability of capturing the highest upside of profitability by setting a range of bid/sale prices that have a propensity to exhaust any competing bidder's purses before ones own purse such that the most desirable assets transact with the highest preservation of capital. Pricing decisions are brought into focus by an analytically robust process because pure anecdotal business judgment can be augmented by a data driven approach not subject to a hidden agenda, personality or unilateral knowledge.

Detail Description Paragraph - DETX (40): [0057] Each potential bidder has a range of possible bids that might be submitted to a sealed bid auction. The range of bids can be expressed as a statistical distribution. By stochastically sampling from a distribution of bid values, one possible auction scenario may be simulated. Further by using an iterative sampling technique, for example a Monte Carlo analysis, many scenarios are simulated to produce a distribution of outcomes. The distribution of outcomes include a probability of winning the auction item(s) and the value gain. By varying the value of ones own bid, a probability of winning the auction against ones own bid price can be determined.

Detail Description Paragraph - DETX (41): [0058] The following core elements are used to simulate a competitive bidding yield, codification of market rules and contracts into computerized business rules, codification of potential competition/market forces, forecasted budgets and priorities into a preference matrix, one's own bidding capacity, preferences, risk/return tradeoffs agreed to codified into a preference matrix, and a computerized stochastic optimization.

Detail Description Paragraph - DETX (42): [0059] Analysis 160 simulates a competitive environment with other companies having various financial capabilities bidding against the bids calculated by system 28. In one embodiment, analysis 160, for example and without limitation, includes a total bid limit such as would be the case where the total value of the assets exceed the financial capabilities of the entity using system 28. In one embodiment, analysis 160 might assess the profitability, in such case of limited resources to bid, of bidding on various combinations of tranches. Analysis 160 also takes into account past history in bidding against known competitors and information on the various types of assets preferred by competing bidders. In analysis 160, the tranche bid is then evaluated and set by management 162 and a final tranche bid 164 made. All valuations prior to the making of the bid 164 can be repeated as desired. Further, since the process is self-adjusting and iterative, the tranche bid price 164 tends to climb upward with each iteration as more and more value is found by the iterations performed by system 28.

Detail Description Paragraph - DETX (43): [0060] The process described by flowchart 85 includes

an evaluation stage 166 (shown in FIG. 3) and a bid preparation stage 168 (shown in FIG. 4). Evaluation stage 166 includes procedures 14, 34 and 40. Evaluation stage 166 runs constantly until stopped, with the automatic valuation procedure 40 and sampling procedures 34 attempting to find extra value in various assets or categories of assets.

Detail Description Paragraph - DETX (44): [0061] Referring once again to FIG. 2, and in accordance with rapid asset valuation, data categories 170, 172 and 174 within the assets of portfolio 12 are identified on each asset and stored in database 76. Iterative and adaptive valuation process 32 takes portions of selected data 78 and applies criteria 80 to the portions of selected data 78 in a statistical manner to increase the known asset value rather than the asset value being a gross extrapolation 20. In accordance with method 28 the assets are divided into at least first portion 16, second portion 36 and third portion or remainder 42. Using procedure 14, the assets in portion 16 are fully underwritten to determine valuation 98 and partial value fully underwritten valuation 104 and to establish criteria 80 for such valuation. Using procedure 34, process 28 samples a quantity of assets from second portion 36 representative of groups in second portion 36 to determine full sampling group valuation 118 and partial sampling credit values 132 for second portion 36 and to establish additional criteria 80 for such valuation. Using procedure 40, partially supervised learning process 206 and partially unsupervised learning process 208 are performed by an automated analyzer such as computer 38 of FIG. 2. In order to learn, the automated analyzer extracts established criteria 80 and selected data 78 as to third portion or remainder 42 and divides third portion 42 into portions 46, and then further divides each portion 46 into categories 48 and 50 and category 50 into clusters 52, 54 and clusters 52, 54 into subclusters 56, 58, 60, 62 and 64 using criteria 80 imported from database 76 and each of processes 206 and 208. Individual asset valuations are established for the assets in subclusters 56, 58, 60, 62 and 64 by statistical inference.

Detail Description Paragraph - DETX (45): [0062] The individual asset valuations are listed in cluster tables 136 (see FIG. 3) and after adjustment 138, listed in a credit analyst table 140. The established criteria 80 are objective since criteria 80 come from database 76 where they have been placed during full underwriting procedure 14 and sample underwriting procedure 34. In other words, information obtained in full value table 96, partial value table 102, table 116, alpha credit analyst table 126, adjusted credit analyst table 130, adjusted credit analyst table 140 and untouched asset table 144 for all assets is placed into database 76 in a digital storage device, such as the hard disk storage 178 of computer 38, and correlations are made by procedure 40 with criteria 80 from procedures 14 and 34. During procedure 40, criteria 80 which are of statistical significance with an acceptable degree of reliability, are entered. That is, procedure 40 iteratively learns as it values and establishes criteria 80. Supervised learning process 206 and unsupervised learning process 208 increase the accuracy of statistically inferred valuation 142 by correlating to established criteria 80 in database 76 on assets in fully underwritten first portion 16 and assets in sample underwritten second portion 36. Selected data 78 related to one or more assets in third portion 42 similar to selected data 78 on assets in portions 16 and/or 36 are located in database 76 and then by statistical inference, a value for each asset in third portion 42 is determined from the located information.

Detail Description Paragraph - DETX (50): [0067] In order to provide the best forecast of asset

value, assets are evaluated by each method within a food chain until such time as they are valued by the best available method for each particular asset. Once this best value is found, the asset is said to have its value, irrespective to other values lower (with more variance) in the food chain and is sent to the completed state.

Detail Description Paragraph - DETX (53): [0070] The food chain approach provides an ability to find the best probability distribution shape, reduces probability distribution variance (especially on the downside tails), provides capability to establish probability distributions quickly while preserving all available knowledge in the constituencies and provides the ability to provide the best estimate of value at any point in the discovery process.

Detail Description Paragraph - DETX (54): [0071] As shown in FIG. 4, the general framework of bid preparation stage 168 is to price bid 164 similar to option valuation paradigms where the winning investor will have the right, but not the obligation, to recover the investment. The values are desegregated into three parts for each tranche, a time value of money component, an inherent value component and a probable cash flow component. The time value of money and the inherent value are deterministically calculated and have little variation once established. The time value of money is computed by taking a firm's cost of capital for a low risk investment multiplied by the investment for the applicable period which represents an opportunity for alternate investment that is foregone in order to make the present investment. Inherent value is a known liquid asset value, which is in excess of the purchase price and is available immediately after taking control of the assets. One embodiment is a well traded security purchased below market value as part of a portfolio. Probable cash flow variance is a function of the assumptions a due diligence team makes and the process it selects to convert raw data into a cash flow recovery stream. The systems described herein are configured to reduce negative variances and find value.

Detail Description Paragraph - DETX (56): [0073] For example, the cash flow recovery timing can be broken down into three bins of 0-6 months, 7-12 months, 13-18 months, and so on. The automated analyzer 38 using algorithm 134 can select the bin width based upon a sensitivity study trade off of timing to valuation against the gauge recovery and rate determined possible by an underwriter. In an exemplary embodiment, a minimum of 4 bins should be utilized when the discount factor is more than 25%. For a discount factor between 10 and 25, a minimum of 6 bins should be used to cover the likely recovery periods.

Detail Description Paragraph - DETX (70): [0087] the calculated sample size, n, and associated underwritten values will estimate the total cluster recoveries to within an error of h, assuming that estimates of total segment recoveries are determined using Equation D.

Detail Description Paragraph - DETX (73): [0090] The appropriate variance adjusted forecast is made for each asset and the valuation tables are constructed to include every asset in the portfolio. The recovery is valued with continuous probabilities at the unit of sale, which in one embodiment is a tranche. In the use of system 28, internal rate of return ("IRR") and variance would then be assessed. Preferred tranches have lower variances for a given IRR. The probability of each tranche's net present value ("NPV") to be above 0 is assessed using the project's discount rate. A

discount rate is determined from the opportunity cost of capital, plus FX swap cost, plus risks in general uncertainties inherent in the variances of forecasted cash flow recovery. If it appears that there is more than a five-percent certainty that the project will have a negative NPV, no bid is made. Deal evaluation is by tranche with decision criteria being IRR, risk variance of the IRR in a tranche, estimated willingness and ability of the tranche to pay, time to profit ("TPP") and the risk variance in the payback by tranche, and NPV of the expected cash flow by tranche discounted to risk free rate.

Detail Description Paragraph - DETX (77): [0094] Using NPV can be misleading due to the effects associated with double discounting which will occur when pessimistic case scenarios are discounted to obtain PV. Using time to profit is used to overcome this limitation and the marginal capital cost or risk free rate is used in the discounting as determined by analysts conducting the evaluation.

Detail Description Paragraph - DETX (80): [0097] FIG. 8 illustrates an alternate exemplary inferred valuation process 240 used in place of the process described in FIGS. 3 and 4. In alternate process 240, a seven-step process is used to rapidly value a real estate loan portfolio using a combination of full underwriting, partial underwriting and inferred valuation. First, assets are sampled 242 according to risk. Second, assets are underwritten 244, and valuations recorded. Third, market value clusters are formed 246, such as by FCM, as described below. Fourth, regression models are built 248, for the underwritten assets. A best model is selected 250, for the underwritten assets from among those built 248 earlier. Sixth, the counts for the selected models are calculated 252. Seventh, models are applied 254, as selected 250 to non-underwritten or inferentially valued portion 42 of portfolio 12 in a manner weighted by the counts to predict individual values for each of the non-underwritten assets. The individual asset values produced according to process 240 are then placed in adjusted credit analyst table 140 (see FIG. 3).

Detail Description Paragraph - DETX (81): [0098] In sampling assets 242, underwriters use stratified random sampling to select assets for detailed review. Strata are constructed from collateral attributes. Examples of collateral attributes for real estate portfolios include, collateral usage (commercial or residential), previous appraisal amount, market value cluster (predicted from previous appraisal amount, land area, building area, current appraisal amount, court auction realized price, property type and property location. Typically, assets are sampled in an adverse manner, i.e., purposely selected from a list ordered by decreasing Unpaid Principal Balance ("UPB") or Previous Appraisal Amount ("PAA").

Detail Description Paragraph - DETX (85): [0102] Two approaches to assess the performance of a CART based model are outlined below. One approach utilizes a ratio of the sum of squared error (SSE) of a CART based approach to that of a simple model, called an error ratio. A simple model is a model which assigns an average asset price to all assets. The second approach computes a coefficient of determination, denoted as  $R_{sup.2}$ , and defined as

Detail Description Paragraph - DETX (90): [0106] A second step is to compute SSE values for each portfolio segment of interest for the CART model and for the simple model (extrapolation

of an average price). An error ratio is computed from the SSE based on the CART model divided by an SSE based on the simple model. If the error ratio is less than one, then the CART based model is a better predictor than the simple model. As an added benefit, a superior model can be assembled as a "hybrid" combination of the CART and simple models, by choosing the model which performs best in each segment, according to the error ratio metric.

Detail Description Paragraph - DETX (92): [0108] Lastly all the segments are ranked based on the error ratio computed in the second step and the R.sup.2 values computed in the third step. The model is accurate in predicting price values for segments that rank high on both of the two metrics, the error ratio and R.sup.2 and superior models are assembled using these metrics.

Detail Description Paragraph - DETX (96): [0112] The lower portion of FIG. 11 is a table illustrating an exemplary embodiment of selecting best models 250 from six models built in accordance with building models 248d. The models differ according to which variables are used as X's. All models use CUMV Cluster (these are present for all assets). The models from building models 248 are used to predict Court Auction Value ("CAV") 256 in addition to Market Value ("MAV") 258. Other embodiments (not shown) use other models to predict other values

Detail Description Paragraph - DETX (98): [0114] where y is the UW value to be predicted, and .sub.k is a prediction from the k.sup.th regression model, for k=1, 2, . . . , K.

Detail Description Paragraph - DETX (100): [0116] When applying models 254, the weighted average prediction from all models that yielded a prediction for each non-UW asset is used. The weights are constructed from the frequencies of the counts calculated 252, and the predictions come from the modeling process. In one embodiment, a commercial statistical analysis software (SAS) system is used to produce the models. An artifact of using the SAS system is that each non-UW asset will get a predicted UW value from each model for which the non-UW asset has each input variable, i.e., "X variable" present. Other modeling packages share this trait.) Equation E below details the procedure. 
$$y_{ij} = \sum_{k=1}^K w_{ijk} y_{ijk}$$
 (Equation E)

Claims Text - CLTX (2): 1. A method for determining a winning bid, at an optimal bid price, for a sealed bid auction, said method comprising the steps of: determining a distribution of bid values possible from competing bidders; selecting a bid value; randomly sampling other bid values to generate one possible auction scenario; and determining a probability of winning the auction versus the selected bid value.

Claims Text - CLTX (8): 7. A method according to claim 1 wherein said step of determining a distribution of bid values possible from competing bidders further comprises the step of determining financial capabilities for at least one of the possible competing bidders.

Claims Text - CLTX (9): 8. A method according to claim 1 wherein said step of determining a distribution of bid values possible from competing bidders further comprises the step of codifying market rules and contracts into computerized business rules suitable for a simulation.



Claims Text - CLTX (10): 9. A method according to claim 1 wherein said step of determining a distribution of bid values possible from competing bidders further comprises the step of codifying at least one of potential competition, market forces, forecasted budgets, priorities, risk and return tradeoffs into a preference matrix.

Claims Text - CLTX (11): 10. A method according to claim 1 wherein said step of determining a distribution of bid values possible from competing bidders further comprises the step of codifying past bidding history of competing bidders based upon knowledge of tranche types preferred by competing bidders.

Claims Text - CLTX (12): 11. A system for determining a winning bid, at an optimal bid price, for a sealed bid auction for tranches of asset portfolios, said system comprising: a computer configured as a server and further configured with a database of asset portfolios; at least one client system connected to said server through a network, said server configured to determine a distribution of bid values possible from competing bidders, select a bid value, randomly sample other bid values to generate one possible auction scenario and determine a probability of winning the auction versus the selected bid value.

Claims Text - CLTX (22): 21. A computer for determining a winning bid, at an optimal price, for tranches of asset portfolios, said computer including a database of asset portfolios, said computer programmed to: determine a distribution of bid values possible from competing bidders; select a bid value; randomly sample other bid values to generate one possible auction scenario; and determine a probability of winning the auction versus the selected bid value.